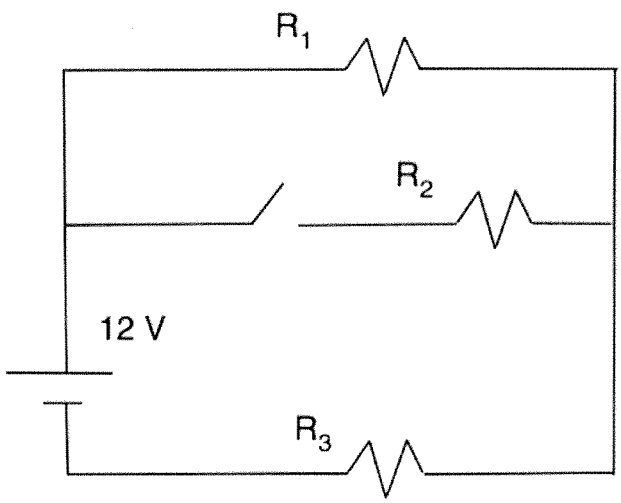
Physics 10164 - Exam 2A

Partial credit will be given provided you show all work and are solving parts of the problem correctly. Points will be deducted if you don't show your work even if you get the right answer. Clearly indicate your answer with a circle or a box and remember to include correct units and significant figures.

1. (40 pts) For the circuit below, R_1 = 1.0 Ohms, R_2 = 2.0 Ohms, and R_3 = 3.0 Ohms.

a) When the switch is open, what is the power dissipated by the resistor R3?

b) When the switch is closed, does the power dissipated by R3 increase, decrease or remain the same? Justify your answer logically or mathematically.



With S open, $R_1 + R_3$ in series, so

$R_{TOT} = R_1 + R_3 = 4\,\Omega$

$I_{TOT} = \frac{\Delta V_{TOT}}{R_{TOT}} = \frac{12}{4} = 3\,A$

Since $R_1 + R_3$ in series,

$I_1 = I_3 = I_{TOT} = 3\,A$

a)

$P_3 = I_3^2 R_3 = (3)^2(3) = 27\,W$

b) R_{TOT} decreases since current has more paths to follow.

Since $R_{TOT} \downarrow$, $I_{TOT} \uparrow \Rightarrow I_3 \uparrow$ and $P_3 \uparrow$

Math: $\frac{1}{R_{12}} = \frac{1}{R_1} + \frac{1}{R_2} = \frac{1}{1} + \frac{1}{2} = \frac{3}{2}$ $R_{12} = 0.667$

$R_{TOT} = R_{12} + R_3 = 3.67$

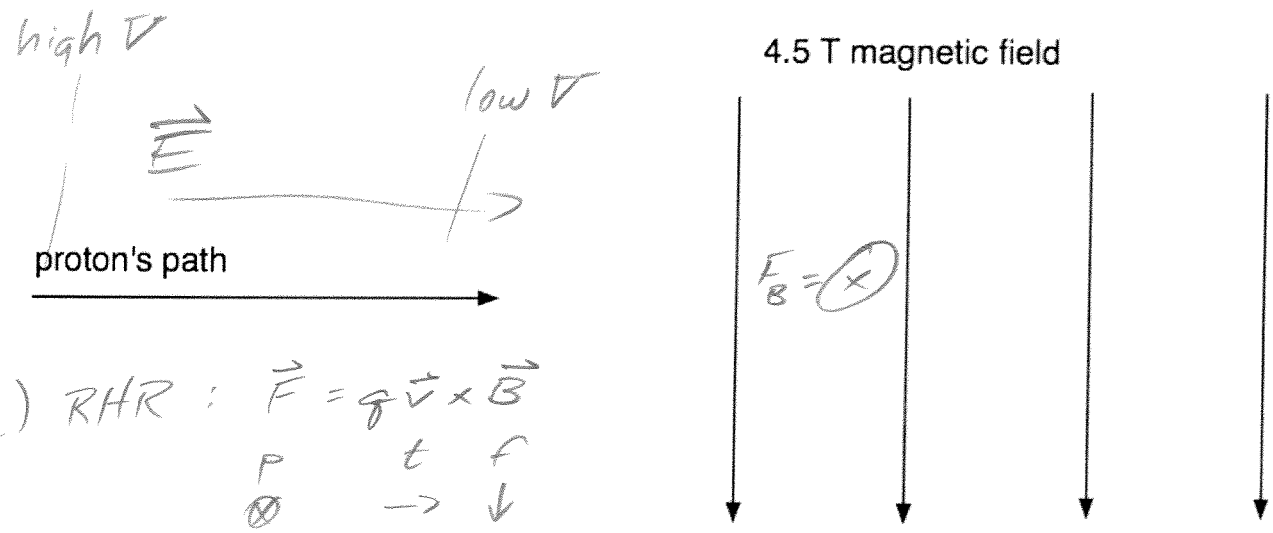
$I_{TOT} = \frac{12}{3.67} = 3.27 = I_3 \Rightarrow P_3 = 32\,W \uparrow$

2. (30 pts) A proton starts at rest and is accelerated through a potential difference of 240 Volts in the +x direction. It then enters a region of a 4.5 Tesla uniform magnetic field in the plane of the page pointing toward the bottom of the page as shown.

a) In what direction is the magnetic force felt by the proton?

b) The proton begins to move in a circular path perpendicular to the magnetic field lines. What is the radius of the circle?

c) What must be the magnitude and direction of the uniform electric field needed in this region to ensure the proton moves in a straight line upon entering the region?



a) RHR : $\vec{F} = q\vec{v} \times \vec{B}$

p t f

$\otimes \quad \rightarrow \quad \downarrow$

b) $r = \frac{mv}{qB}$

$m = 1.67 \times 10^{-27}$

$q = 1.60 \times 10^{-19}$

$B = 4.5\,T$

$v = ?$

$\Sigma W_F = W_E = \Delta K$

$-q\Delta V = \frac{1}{2}mv^2 - \cancel{0}$ ($v_0 = 0$)

$-(1.60 \times 10^{-19})(-240) = \frac{1}{2}(1.67 \times 10^{-27})v^2$

$v = 2.14 \times 10^5\ m/s$

$r = \frac{(1.67 \times 10^{-27})(2.14 \times 10^5)}{(1.60 \times 10^{-19})(4.5)} = 4.97$ or $5.0 \times 10^{-4}\ m$

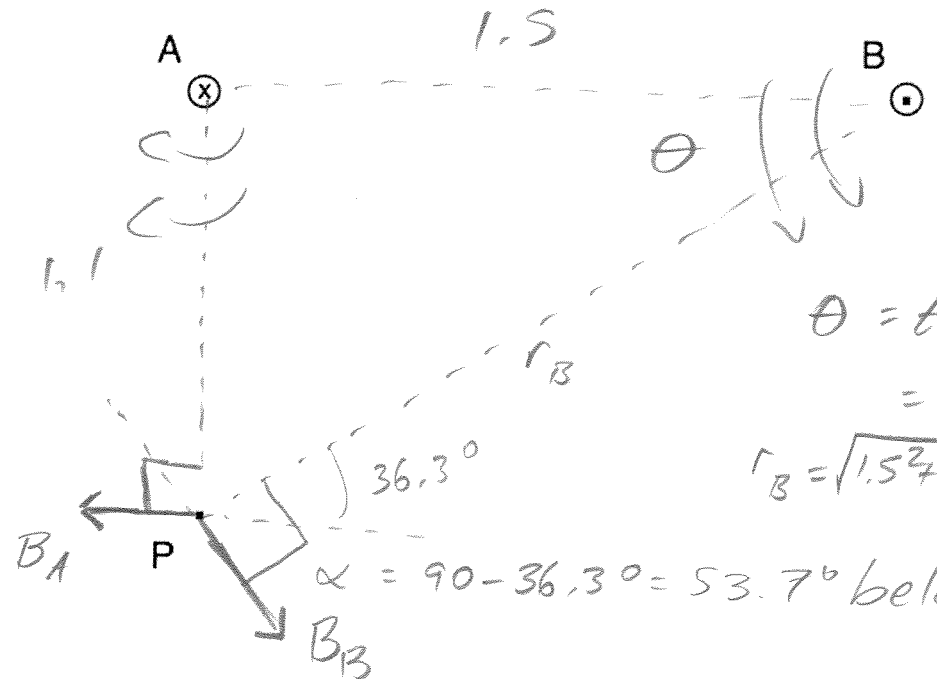
c) If $F_B = \otimes$, F_E must point $\odot$, so $\vec{E}$ also points $\odot$

$|F_E| = |F_B| \Rightarrow qE = qvB \Rightarrow E = (2.14 \times 10^5)(4.5)$

$= \boxed{9.6 \times 10^5\ \frac{V}{m},\ \odot}$

#3. (30 pts) Wire A carries a current of 3.0 Amps and passes through the origin. Wire B carries a current of 7.2 Amps and passes through the x-axis at x = 1.5 meters.

Determine the magnitude and direction of the magnetic field due to these two wires at point P, which is at coordinate (x,y) = (0,-1.1) meters.



$\theta = \tan^{-1}\left(\frac{1.1}{1.5}\right)$

$= 36.3°$

$r_B = \sqrt{1.5^2 + 1.1^2} = 1.86\,m$

$\alpha = 90 - 36.3° = 53.7°$ below $+x$

$$B_A = \frac{\mu_0 (3)}{2\pi(1.1)} = 5.45 \times 10^{-7}\,T, \quad -x$$

$$B_B = \frac{\mu_0 (7.2)}{2\pi(1.86)} = 7.74 \times 10^{-7}\,T, \quad 53.7 \text{ below } +x$$

$B_{A,x} = -5.45$

$B_{B,x} = 7.74 \cos 53.7°$

$= 4.58$

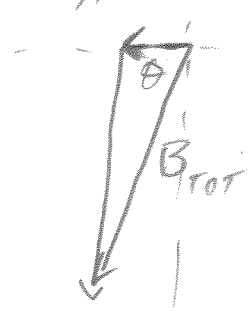
$B_{TOT,x} = -0.87$

$B_{Ay} = 0$

$B_{By} = -7.74 \sin 53.7°$

$= -6.24$

$= -6.24$



$|B_{TOT}| = \sqrt{.87^2 + 6.24^2} = 6.3 \times 10^{-7}\,T$

$\theta = \tan^{-1}\left(\frac{6.24}{.87}\right) = 82°$ below $-x$